Semi-vegetarianism – good for animals, good for the environment and good for humans

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ABSTRACT

The world's population is burgeoning having increased from four billion in 1975 to 7.4 billion at the beginning of 2016. Thus, we need more food and this places more pressure on the environment. Coincident with this change, rates of obesity and of adverse mental health conditions are increasing in most developed countries and also in some developing countries thus burdening health systems. Furthermore, in the time that the world's population has doubled, the consumption of meat has tripled. Large population studies associate high meat consumption with deleterious health and reduced longevity so much so that the World Health Organization has labelled meat a carcinogen. Modern meat production depends on intensive animal production and the feeding of crops to animals, commonly known as "factory farming" or, more formally, "Industrial Farm Animal Production" (IFAP). This industry produces such a high proportion of the animals we eat that any reduction in meat eating will likely see less IFAP. The dominance of IFAP makes it a key contributor to climate change, with emissions estimated at 7.1 gigatonnes CO_2-equivalents per annum, or 14.5% of human-induced greenhouse gas emissions. Added to this, the intensive production of animals raises many questions concerning their welfare. In this paper I argue that a largely vegetarian diet makes environmental sense while also offering health benefits and improved animal welfare. The latter occurs by farming fewer animals and by caring for them better. I focus on the health benefits because this is the crux of the issue; if people ate less meat – moved towards a vegetarian diet, then we would be healthier and would also mitigate the environmental and animal welfare problems associated with IFAP. Education is the key. If people understand the origins of their food and the benefits to gain by eating a largely plant-based diet – one where plants are the staples, then there is some hope of tackling a system that has enormous economic and political power. Currently, education fails; only 5% of Australians eat the recommended helpings of fruit and vegetables and do the recommended amount of exercise. The best change we could make in terms of health, environment and welfare would be to refrain from the offerings of the fast-food industry. These food outlets depend on IFAP and have been widely criticised for marketing unhealthy products. The small amounts of meat eaten in a semi-vegetarian existence would come from sustainable animal production where welfare is paramount.

Key words: environment, mental health, lacto-ovo-vegetarian, omnivore, vegan, welfare

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The human population is burgeoning tripling from 2.5 billion in 1950 to 7.4 billion at the beginning of 2016 (Worldometers 2016). While the population growth rate is slowing the United Nations still predict that it will reach 10 billion in 2056 and be between 9.5 and 13.3 billion (95% confidence interval) in 2100 (United Nations 2015). While much of the increase will be in developing countries, even the population of the USA will likely double to about 600 million in the next 60 years (Pimentel and Pimentel 2003). As long ago as 1971, Ehrlich and Holdren (1971) argued that population growth is responsible for most of the Earth's environmental problems from the loss of species to the contamination of land, air and water. Changes in Africa in the last 50 years exemplifies these claims: the population increased by 272% but the per capita Ecological Footprint – the goods and services used by an average person and the efficiency of their use, hardly changed (WWF International 2014). Likewise, China ranks 76th on Ecological Footprint so again increase in population is the main determinant of resource use (WWF International 2014). It is in highly developed nations that increasing consumption determines the footprint.

Given the reliability of previous population estimates, it is unlikely that anything will prevent the addition of three billion people to the current population. Thus, the only solution to avoiding an impending catastrophe for humans in the industrialised world to use resources sustainably, something that largely disappeared with the industrial revolution.

In this paper I discuss the hypothesis that a semi-vegetarian lifestyle would benefit humans, it would benefit the environment and it would benefit animals. There is no doubt that the way we now raise most animals – in an industrialised way, is the cause of most of the environmental damage done by farming livestock and it also attracts most of the criticism, on welfare grounds. As I will discuss, there is a close association too between Industrial Farm Animal Production (IFAP), the preponderance of fast-food restaurants, the use of motor vehicles and human health (Fraser *et al.* 2010; Burgoine *et al.* 2014). Fast-food restaurants are important outlets for the products of IFAP, typically offer "drive-through" facilities and their products are associated with poor health. As discussed by Wallis (2014), IFAP and the fast-food industries grew hand-in-hand, with a particularly close association between the expansion of the chicken meat (broiler) industry and the number of Kentucky Fried Chicken (now KFC) outlets.

I allocate most of the paper to a discussion of the benefits to humans of a vegetarian existence because this is the crux of the matter. Put differently, any reduction in meat eating would most likely yield environmental and animal welfare benefits, because most of our meat now comes from intensively reared livestock.

The aim of the paper, however, is not to argue for a vegetarian lifestyle – although the benefits are many, but instead to stimulate a debate about the benefits of eating less meat, especially that from IFAP and particularly that from fast-food outlets. In this paper "meat" refers to terrestrial vertebrate flesh and ignores fish and other animal protein. The term "vegetarian" refers to ovo-lacto-vegetarians – those who consume eggs and dairy products. Plant-based diets refer to those that are predominantly plant material but may include the small amounts of meat that various organisations suggest people eat. For example, The Food and Agriculture Organization of the United Nations (FAO), (2016a) recommend 20 g of animal protein per day – 25-30% of our daily protein requirement.

Background

Meat consumption

Hand in hand with the massive increase in population has been unprecedented economic growth in many parts of the world, but particularly China, India, Brazil and especially sub-Saharan Africa (World Bank 2016). An obvious consequence of an increasing population is the need for more food. A less obvious consequence of people getting wealthier is that they eat more meat (Gerbens-Leenes *et al.* 2010) and waste more food (FAO 2011). While it is desirable that people are escaping poverty, in the 45 years that it took the world's population to double to 7 billion, global meat consumption tripled from 109 to 319 million tonnes (FAO 2014). The FAO estimates that it will reach 455 million tonnes by 2050 (FAO 2014).

As expected, during the same period the number of domesticated animals rose steeply and the number of wild animals declined as farmers cleared land for crops and for grazing (Carey and Oettli 2006). Populations of vertebrate animals are half what they were 40 years ago, with the biggest declines in Latin America (WWF International 2014). The loss of vertebrates in Latin America, especially Amazonia, coincides with extensive land-clearing, mainly for pasture but also for crops, particularly soybeans (De Sy *et al.* 2015). Since 1961 the number of cattle slaughtered globally has increased by 70%, sheep by 60%, goats and pigs by 400%, buffalo by 300% and chickens 1000% (Table 1) (FAOSTAT 2014). Clearly, to sustain these numbers requires the farming of many more animals, primarily breeding stock. Also, I mention just the main species; humans eat many more from both wild and domesticated species including turkeys, ducks, various rodents, horses, camels, guinea pigs, wild ruminants, horses, camels and reptiles to name just a few. And these are just the terrestrial animals; there are also animals acquired through aquaculture and seafood.

Table 1. The changes over 40 years in the numbers of animals of selected species slaughtered around the world and in Australia (FAOSTAT 2014).

	Animals slaughtered annually (x 10^6)			
Species	**World 1961**	**World 2012**	**Australia 1961**	**Australia 2012**
Cattle	173	296	4.28	7.9
Goats	103	440	0.01	1.0
Sheep	330	536	32.6	24.9
Chickens	6,600	60,000	36	555
Pigs	376	1,394	2.2	4.7
Buffaloes	7.7	25	0	0
Total	7,589	62,691	75.1	593

There is not a clear explanation for the trend in meat eating in humans especially given the gastrointestinal anatomy that points to omnivory (Stevens and Hume 2005). Although eating meat is part of our evolutionary heritage (Smil 2013) – chimpanzees fortify their largely herbivorous diet with animal protein (first reported by Jane Goodall in the 1960's see Uehara 1997), anthropologists no longer believe in a carnivorous yearning – a physiological explanation, but instead suggest that it relates to sex, power and money – that is, culture (Renton 2013). If so, one can be optimistic that culture can change. While there is still a tremendous gulf in wealth between inhabitants of developed and less-developed countries there is a similar gulf in meat consumption. On average each inhabitant of the globe eats about 43 kg of meat a year (Chartsbin Statistics Collector team 2013). However, people who live in developed countries and have more money tend to consume amounts of meat (90-100 kg per year) that are detrimental to their health, while those in impoverished places cannot afford the small amounts of meat that would greatly enhance their nutritional status. The FAO suggest that to effectively combat malnutrition people require 20 g of animal protein per day, which equates to 33 kg of lean meat, 45 kg of fish, 60 kg of eggs or 230 kg of milk. They concede, however, that although nutrients from animals may be of higher quality or more readily absorbed than are those from vegetable sources, it is possible to have a healthy vegetarian diet (FAO 2016a).

Apart from the increase in meat eating with growing affluence there has also been a change in the types of meat eaten. The changed consumption among Australians illustrates this well (Table 2). It is interesting to note that the period of interest – roughly the last 50 years, coincides with the expansion of the main fast-food chains – McDonalds, KFC and Burger King, all of which rely on selling meat. Concealed among these changes in consumption are changes in animal husbandry. Fifty years ago Australians ate meat predominantly from grazing animals – sheep and cows that convert substances that humans cannot eat (cellulose and hemi-cellulose) into meat – something that humans can eat. Now, most of the meat eaten in Australia comes from chickens and pigs. Unlike the situation 50 years ago when chickens and pigs were sideline industries (see Wallis 2014), they are now intensively housed and fed on crops (grains and legumes) that are perfect food for humans. This form of agriculture goes by several names including "factory farming" – the derisive term in the popular media or, more formally, "Industrial Farm Animal Production" (IFAP), which I use here.

Table 2. The changing annual consumption of different meats in Australia in the last 50 years (FAOSTAT 2014)

	Annual consumption (kg per capita)					
Year	Beef and veal	Lamb	Mutton	Chicken	Pork	Total
1962	45.3	19.3	25.2	4.4	8.8	103
2013	35.7	11.9	0.3	44.8	25.0	118

Even the production of Australian beef is changing especially in temperate zones. Where once beef cattle started and ended their lives grazing there is a tendency now to follow an American model whereby animals start their lives grazing and end it in feedlots where they eat more concentrated diets. At any time, there are about 800,000 cattle in Australian feedlots. Thus more than 30% of the cattle slaughtered in Australia spend time in a feedlot (Australian Lot Feeders Association 2014), which falls under the category IFAP. On average, each animal spends 95 days in a feedlot where it eats 800 kg of food containing 50% grain. These grains – maize, sorghum, wheat, barley and triticale contain about 10% protein (National Research Council 1994), so annually, three million cattle consume 1.2 million tonnes of grain or 120,000 tonnes of protein – 20% of the protein requirement of Australia's human population. No one can state the foolishness of feeding grains to ruminants more aptly than well-known ruminant nutritionist, E. R. Ørskov, in his letter to Ecological Economics:

> *"Feeding grain to ruminants is biological and economic nonsense: it is a misuse of arable resources, a misuse of a ruminant animal's objective potential, it is polluting, it is dependent on whims of economic policy and it is driven by commercial gain, not human need"* (Ørskov 1999).

In summary, those in the developed world get most of their meat from animals fed crops that are perfectly suited to human consumption. Thus, almost any reduction in the consumption of meat will offer environmental benefits and benefits to animals due to a reduction in IFAP.

Vegetarianism

Vegetarian diets are those based on foods from plants, such as grains, vegetables, fruits and nuts, to the exclusion of meat products. In a paper on the history of vegetarianism, Leitzmann (2014) noted that it is an ancient practice with most early human settlements eating plant-based diets – one where plants are the staples (Leitzmann 2014), and two of the world's main religions – Hinduism and Buddhism advocating vegetarianism from their conception (Spencer 2000). Even the recorded history of vegetarian nutrition dates from the sixth century BC in the writings of the Greek philosopher Pythagoras, the father of ethical vegetarianism. Since then the practice has ebbed and flowed but gained a strong foothold in the latter parts of the twentieth century when research refuted the myths about nutritional deficiencies associated with vegetarianism and expounded the many benefits (Sabaté 2003).

Several terms describe vegetarian diets while people offer many reasons for adopting a vegetarian lifestyle. Lacto-ovo-vegetarians are those who supplement a plant-based diet with milk products and eggs while pesco-vegetarians also eat fish and other seafood. Semi-vegetarians are those who eat small amounts of meat (defined as less than once per week in Adventist health studies (Orlich and Fraser 2014)). A typical reason given by semi-vegetarians is that they eat it irregularly, for instance at social occasions. At the other end of the spectrum are vegans, who consume no food of animal origin and often refrain from using animal products, such as leather or even honey. The three main reasons cited for adopting a largely plant-based diet are environmental, health and ethical concerns. All of these reasons can be subdivided. Concerns on environmental grounds include the destruction of forests to open land for growing crops used for animal feed, the contamination of waterways, and excretion of methane by ruminants – one of the most potent greenhouse gases, or the vast wastage on many fronts associated with feeding crops to livestock. Likewise, people give a variety of ethically-based reasons for not eating meat including the industrialisation of animal production, the transport and especially live export of animals or their general exploitation (Lea and Worsley 2003). Some of these reasons have a religious background such as Hindus, various Buddhist sects and the Seventh Day Adventist Church advising parishioners not to eat meat. Out of interest, vegetarians have also come under attack most notably after the Russian Revolution when the state banned vegetarian societies and persecuted their leaders (International

Vegetarian Union 2002). The tide has turned and now the meat industry is defending itself (North American Meat Institute (NAMI) 2014) against a raft of criticism covering many of its practices.

The different degrees of vegetarianism obscure any estimates of world-wide numbers of vegetarians although estimates of between 400 and 500 million are common (Heinrich Böll Foundation and Friends of the Earth Europe 2014). In developed countries, especially, there are far more people who claim to be vegetarians than researchers report after examining dietary records. The problem, however, with such simplified diet records is that they overlook people who eat a mainly plant-based diet. After all, what we wish to know, especially in things like health surveys, is how much and what types of meat people eat and the variation that surrounds it. Reid *et al* (2012) measured this and determined that seven out of ten Australians had increased their consumption of plant-based meals in the past 10 years. Likewise in Britain: one in eight British adults and 20% of those aged between 16 and 24 years now follow vegetarian or vegan diets. Millions more have cut back on the meat they eat (Mintel 2014). The situation globally reflects this with launches of new vegetarian food and drink products doubling between 2009 and 2013 (Mintel 2014). This increase in consumption of plant products may seem counterintuitive given that the global consumption of meat continues to rise. One explanation is population growth. Another answer is the increased meat consumption with economic growth in countries like China. A third explanation is that some cohorts may eat less meat while others eat more.

It is futile to expect people to suddenly refrain from eating meat and to adopt a vegetarian existence. More plausible – and most beneficial from health, environment and welfare perspectives, is the thought that people might rely less on meat from IFAP, particularly that sold from fast-food outlets.

Semi-vegetarianism – good for humans

Cutting back on the consumption of meat benefits humans in many ways. Chief among these is the benefit to health, both physical and mental. But there are other less obvious benefits of eating less meat. Most of these relate to the industrial scale of modern meat production and include the violence that permeates societies with abattoirs, the appalling record of work safety in the meat industry and the poor hygiene in the meat food chain leading to an increased risk of zoonoses from the industrial production of animals. The following sections briefly discuss these issues with a focus on the benefits to human health of eating less meat. It also discusses some of the doubts often posed about vegetarianism, such as obtaining the required nutrients and engaging in athletic pursuits.

Diet and health

It is a nutritional fact that humans do not have to eat any animal products in order to live healthy lives with substantial lifespans as long as the supply of food is plentiful and varied, allowing a continuous intake of essential nutrients (Craig and Mangels 2009). In contrast, people who cannot access sufficient food will likely have an inadequate consumption of essential nutrients that will quickly manifest as nutritional disease. Prime examples are trace element deficiencies, such as selenium or iodine, or inadequate amounts of amino acids, the building blocks of protein (FAO 2016a). The effects of malnutrition are many but the result is the same – poor health and lifespan. In addition, those suffering malnutrition usually live in places with poor public health facilities.

At the other end of the spectrum are those people, mainly in developed nations, who face poor health and reduced longevity due to overconsumption and burden what are often excellent health facilities. Nevertheless, there are similarities between rich and poor that concerns inadequate consumption of essential nutrients. As Willett (1999) argues, “In most diets, inadequate consumption of beneficial dietary components, including fruit, vegetables, whole grains, and others high in nonhydrogenated vegetable oils, appears to be more detrimental than is an excessive intake of harmful foods”. This introduces a fundamental aspect of nutrition in those with access to enough food: diets are of a finite size. Thus removing one component from the diet (e.g., animal protein) leaves space to include another (vegetable protein). Eating a large fatty meal leaves little space for the two servings of fruit and five of vegetables recommended each day. Another fundamental aspect of nutrition is that many foods are beneficial in small quantities but detrimental in larger amounts; meat and sugar in the modern Western diet seem prime examples. I refer those who are wondering about how some indigenous populations thrive on animal-based diets – the Maasai and Inuit, for example, to the Centre for Indigenous Peoples’ Nutrition and Environment at McGill University. Their work shows that those indigenous people who rely heavily on animal products often eat more foods than we commonly recognise. For example, researchers identified 65 different foods in the Maasai food system, including many vegetables, herbs and fruits (Centre for Indigenous Peoples’ Nutrition and Environment at McGill University 2016)

If we ignore the influence of religion on diet there is a strong correlation between wealth and a propensity to eat meat (Gerbens-Leenes *et al.* 2010). As noted in the introduction, there is no clear explanation for this phenomenon but it results in the wealthy consuming amounts of meat that appear detrimental to their health while the impoverished do not get the small amounts that would greatly enhance their health.

Due to large population studies in the latter half of the twentieth century, opinions on a vegetarian diet changed from being a practice likely to cause nutritional deficiencies to one that is beneficial for health. This prompted the American Dietetic Association (ADA) to declare that 'appropriately planned vegetarian diets, including total vegetarian or vegan diets, are healthful, nutritionally adequate, and may provide health benefits in the prevention and treatment of certain diseases' (Craig and Mangels 2009).

That vegetarians enjoy unusually good health and live longer than their omnivorous compatriots (Key *et al.* 1999) has prompted many researchers to scrutinise the vegetarian diet. Such studies are complex because they involve three broad questions. First, are vegetarians healthier because they ingest smaller amounts of harmful dietary components – meat and other animal products? Second, are they healthier because they ingest more beneficial components, especially the various chemical compounds in plants? Thirdly, are the effects independent of diet and instead related to other lifestyle factors, such as more physical activity or lower consumption of alcohol and tobacco products? Another possibility is that all or some of these factors explain the difference.

As discussed earlier, one should exercise caution in interpreting the term "vegetarian" from self-reports because many use the term loosely. Many people are mainly vegetarian but, for whatever reason, occasionally eat meat. Although a large proportion of self-identified vegetarians report consuming some type of animal products, such as meat, poultry and/or seafood, their dietary patterns contain more plant-based foods and whole grains with less solid fats and added sugars – the typical advice for most populations (Juan *et al.* 2014). The fact that people eat differing amounts of animal products from none (vegan), to eggs and dairy products (lacto-ovo-vegetarians), and fish (pesco-vegetarians), to small amounts of meat (semi-vegetarians) through to omnivory increases the statistical power of large dietary studies. In contrast, categorising people on whether or not they eat meat can obscure important information in these studies.

Most notable among the studies to decipher the reason for the health benefits of vegetarianism are the Adventist Health Studies (AHS) and the European Prospective Investigation into Cancer and Nutrition (EPIC). The AHS, based at Loma Linda University in California, have examined the links between lifestyle, diet, disease and mortality of Seventh-day Adventists (SDAs). It began in earnest in 1958 with the Adventist Mortality Study with 22,940 participants, the results of which were astounding: life-table analyses showed that Adventist men and women lived for 6.2 and 3.7 years longer than their Californian counterparts due to lower rates of most types of cancer and of pulmonary heart disease (Kuzma and Beeson 1981). The re-analysis after 26 years of the data for men confirms the findings of a positive, linear relation between body mass index (BMI; body mass (kg)/height (m^2)) and all-cause mortality, reported in the original study (Lindsted and Singh 1998b). The equivalent data for women are less clear but the authors conclude that being overweight is a risk factor for fatal disease among women throughout adulthood (Lindsted and Singh 1998a). Kuzma and Beeson (1981) recognised the possibility that selective factors as to who becomes a SDA might explain the results. This, however, seemed unlikely because there was a gradient of increasing risk with decreasing adherence to the SDA lifestyle. Nevertheless, the promising results from the Mortality Study prompted an additional study (AHS-1; 1974–1988) involving about 34,000 Californian Adventists over 25 years of age with the aim of identifying components of the Adventist lifestyle that protect against disease (Adventist Health Studies 2016). The study duplicated the mortality results from the mortality study and showed statistically that five simple behaviours promoted by the Seventh-day Adventist Church – not smoking, eating a plant-based diet, eating nuts several times per week, regular exercise and maintaining normal body weight, explain the increasing longevity. The newest study that started in 2002 – AHS-2, was larger (about 96,000 participants) and broadened the population to include Adventists from other parts of North America. The results of this research are just appearing and reiterate those of the earlier Adventist Health Studies (see Table 3)

There is marked overlap in the Adventist Health Studies that increases their value. Not only are the studies simultaneous but researchers combine the data from the three main studies and from studies elsewhere to make different comparisons and to increase the power of statistical inference. Not surprisingly, a plethora of papers has emanated from the work and these have changed the thinking on the value of a largely vegetarian diet. There are far too many to discuss individually and so I have summarised some of the findings in Table 3, but have also included papers from the EPIC studies. The table shows studies that evaluate the health of vegetarians and others that examine the effect on health of foods that vegetarians prefer or avoid. Fraser (2009) reviewed the findings from many publications on the topic and concluded that vegetarians are less obese and have lower rates of coronary heart disease, largely explained by their lower concentrations of LDL cholesterol. Slightly less certain is whether vegetarians have lower rates of hypertension and diabetes mellitus. Compared to those living in the same community, vegetarians tend to live longer and have moderately lower cancer rates. The results are much less certain for specific cancers. Vegetarians and those who eat less meat appear to have lower incidences of colorectal cancer but results from British vegetarians refute the result. This comes back to the need to identify what people eat rather than categorising their dietary habit.

Perhaps the irony of the results of more than 50 years of study of the Adventist lifestyle is that they tell us what many of us already know and what health bodies

Table 3. A summary of some of the main findings from large population studies of those eating differing amounts of plant products. These include studies that evaluate the health of vegetarians and others that examine the health effects of foods that vegetarians prefer or avoid.

Measurement	Finding	Reference
Meat consumption and longevity	A very low meat intake is associated with greater longevity.	Singh *et al.* (2003)
An Adventist (SDA) lifestyle and mortality	White SDA men lived 7.3 years and white SDA women lived 4.4 years longer than the average white California man and woman.	Fraser and Shavlik (2001)
Vegetarian diets and cardiovascular mortality	Modest cardiovascular benefit but no clear reduction in mortality with a vegetarian diet. The evidence of benefit comes from studies in SDA.	Kwok *et al.* (2014)
Vegetarian diets and body mass index, diabetes mellitus, metabolic syndrome, hypertension, mortality, cancer	Preliminary findings from AHS-2 indicate that vegetarian diets are associated with lower BMI, lower prevalence of diabetes, the metabolic syndrome and hypertension, lower mortality and lower risk of some cancers.	Orlich and Fraser (2014)
Vegetarian diets and ischemic heart disease	Consuming a vegetarian diet was associated with lower IHD risk, a finding that is probably mediated by differences in non-HDL cholesterol, and systolic blood pressure.	Crowe *et al.* (2013)
Degrees of vegetarianism and blood pressure	Vegetarians, especially vegans, have lower systolic and diastolic blood pressure and less hypertension than omnivores. This is only partly due to their lower body mass.	Pettersen *et al.* (2012)
Degrees of vegetarianism and the metabolic syndrome	After adjusting for lifestyle and demographic factors those eating a vegetarian diet have a favourable profile of metabolic risk factors and a lower risk of the metabolic syndrome.	Rizzo *et al.* (2011)
An Adventist (SDA) lifestyle and breast cancer	Obesity increased the risk of breast cancer. Increasing consumption of high fat animal products did not increase the risk of breast cancer.	Mills *et al.* (1989b)
An Adventist (SDA) lifestyle and prostate cancer	Higher educational achievement and eating more beans lentils and peas, tomatoes and dried fruit were all associated with a lower risk of prostate cancer. Changes in BMI did not alter the risk.	Mills *et al.* (1989a)
Vegetarian diet and cancer in Britain	The risk of some cancers is lower in fish eaters and in vegetarians than in meat eaters.	Key *et al.* (2014)
Degrees of vegetarianism and cancer	In comparison to non-vegetarian Adventists, vegans are less likely to be diagnosed with cancer. Also, lacto-ovo-vegetarians are protected from gastrointestinal cancers.	Tantamango-Bartley *et al.* (2013)
Degrees of vegetarianism and colonic polyps	People who consume larger amounts of fibre, especially that from vegetables, had a lower risk of developing colonic polyps.	Tantamango *et al.* (2011)
High protein content (legumes, meat, meat analogues) and hip fracture incidence	Eating more legumes, more meat analogues (e.g., tofu) and, to a lesser extent, meat reduces the risk of hip fracture.	Lousuebsakul-Matthews *et al.* (2014)
Meat consumption and wrist fracture in menopausal women	Adequate protein from either meat or vegetables is necessary for bone health.	Thorpe *et al.* (2008)
Meat consumption and the occurrence of degenerative arthritis and soft tissue disorders	Eating more meat is associated with a higher prevalence of degenerative arthritis and soft tissue disorders in both male and female subjects as is hormone replacement therapy in women.	Hailu *et al.* (2006)
Meat consumption and diabetes	The amount of meat eaten and especially processed meat is a dietary risk factor for diabetes.	Vang *et al.* (2008)
Processed meat and mortality	Results indicate a positive association between processed meat consumption and mortality, due to cardiovascular diseases, but also to cancer.	Rohrmann *et al.* (2013)
Beef consumption and heart disease	In men, but not in women, the risk of fatal heart disease was related to consumption of beef. Men who ate beef three or more times per week had a 2.3 times greater risk of dying than did vegetarian men	Fraser (1999)
Nuts and whole grains and coronary heart disease	Regularly eating nuts and whole-grains lowers the risk of coronary heart disease.	Fraser *et al.* (1992); Sabate (1999)

advocate exercise, eat lots of fruits and vegetables, don't smoke and moderate the consumption of alcohol. Unfortunately, few follow this recommendation. Among 16,000 Australian adults in the 2004-2005 National Health Survey, 55% met the guidelines for two servings of fruit a day, 15% for five servings of vegetables, 25% for 150 minutes of exercise a week and just 5% for the recommended consumption of fruit and vegetables and engaging in exercise (Atlantis *et al.* 2008). It should come as no surprise that Australians are among the fattest people in the world, with nine million people overweight (BMI = 25-30) and five million obese (BMI > 30) and that the rates of obesity have doubled in the last 20 years (Alwan *et al.* 2011). Obesity is the greatest threat to public health in Australia and has even surpassed smoking as the leading cause of premature death and illness in the country. As is so common, Australia's indigenous population are the worst affected (Anderson *et al.* 2006).

Simultaneous with increasing rates of obesity, companies that sell fast-food and alcohol continue as key sponsors of sporting teams and among the frequent advertisers on televised sport and of targeting children (Choice.com 2014). A study by the Australian Institute of Health and Welfare (2012) confirmed this with three simple points. First, the foods advertised are high in fat, sugars or salt. Second, children who watch a lot of television see more of these advertisements. Third, children who watch a lot of television are more likely to be overweight. We do all we can to protect people, and children especially, from harm. We make cars safer, we prohibit drugs and restrict the sale of tobacco and alcohol; we have mandatory helmet laws, controls on the sale of firearms and police checks on people working with children but we fail everyone by allowing purveyors of junk (food) to peddle their wares. The products of IFAP are somewhat to blame because most meals sold at the major fast-food outlets originate in this farming system. Removing these products from our diets and replacing them with meat from sustainably raised animals or, better, with vegetable protein would benefit animals, the environment and humans, including their mental health, as discussed in the next section.

Diet and mental health

Depressive disorders are now the leading source of disability globally (Dash *et al.* 2015) leaving some to ponder a link with lifestyle, in particular the poor nutrition and irregular exercise that I mention in the previous section (Opie *et al.* 2015). There is a logical link between diet and mental health as follows: the brain has a high metabolic rate and thus needs a constant supply of nutrients – amino acids, fatty acids, vitamins and minerals, to function efficiently. Any deficiencies may lead to malfunction and effectively mental health issues (Sarris *et al.* 2015). This was the view of Jacka *et al* (2014) who argued that the comorbidity between physical and mental ill-health has a crucial common determinant – diet. Thus, examining links between mental health and diet is an obvious field of research and a relatively new one.

In a review of the literature, Opie *et al* (2015) found a link between diet and depression that warranted much larger trials. Dash et al (2015) were more forthright concluding that the ingestion of unhealthy diets correlates with the incidence of depression.

The personal view of several members of the International Society for Nutritional Psychiatry Research deserves notice (Sarris *et al.* 2015). They state that:

> *"Now is time for the recognition of the importance of nutrition and nutrient supplementation in psychiatry".*

The link, however, is complex and emerging research suggests some involvement of the body's microbial population – the microbiome. In other words, there is a connection between the microbiome, the gut and the brain. Research has gone so far that those involved now speak of "psychobiotic organisms" – "live organisms that, when ingested in adequate amounts, produce a health benefit in patients suffering from psychiatric illness" (Dinan *et al.* 2013). This suggests a simple solution to some mental health issues by modifying the gut microbes but the main influence on the microbial population is diet (Albenberg and Wu 2014). But, the body's microbes do not just influence mental health; they appear to be the link between diet and health and may explain the benefits of a plant-based diet.

A likely mechanism for the health benefits of a plant-based diet

More and more research on human energy metabolism and its links with health points to a regulating role for volatile fatty acids (VFAs). No vertebrates possess the enzymes for breaking down the components of plant cell walls, principally cellulose and hemicellulose (plant fibre) and instead harbour microbes for this purpose (Stevens and Hume 2005). Regardless of whether this occurs in the foregut (e.g., in ruminants, kangaroo, etc) or in the hindgut (horses, rodents, elephants, humans, etc) one of the main products are VFAs that are absorbed and enter the animal's energy metabolism (Stevens and Hume 2005).

The disruption in the energy balance of humans, particularly in the developed world and increasingly in the developing world with a decrease in physical exercise and a relative increase in energy intake, can lead to the metabolic syndrome. People exhibiting the syndrome are often obese and typically show dyslipidemia, hypertension and a loss of glycemic control (Galisteo *et al.* 2008). The metabolic syndrome is complex with no simple etiology but increasingly research shows roles for dietary fibre and, more specifically, VFA in mitigating the syndrome. For example, eating more fibre has beneficial effects on regulating food intake and body weight, insulin sensitivity and glucose homeostasis (Marlett *et al.* 2002; Venn and Mann 2004; Delzenne and Cani 2005). Epidemiological studies show associations between eating more fibre and a reduced risk of developing cardiovascular disease, diabetes and various gut syndromes including irritable bowel syndrome and colon cancer (Galisteo *et al.* 2008).

Host animals acquire gut microbes at birth and its composition develops and changes throughout life in a process that depends on the host genome, nutrition and life-style. These microbial populations in the gut, often through VFAs, play roles in the regulation of numerous metabolic pathways that physiologically connect the gut, liver, muscle, and brain (Nicholson 2012).

Many people need to change their diets but getting them to change is not simple for, as mention earlier, few Australians consume the recommended amounts of fruits and vegetables in spite of extensive promotion (Atlantis *et al.* 2008).

Diet and preventative health

Preventative health – be it mental or physical, is the best way to remove burden from our health system on which Australia spends about $130 billion dollars a year or 9.2% of GDP. However, in all of the talk on saving money in the recent, long election campaign it failed to get a mention. Promoting a healthy lifestyle and restricting the advertising or sale of unhealthy products is one way to do this (Moodie 2013). Hand-in-hand with this approach would be a mandatory "Traffic Light" system of food labeling to guide consumers towards healthier food choices, such as that recommended by the Royal Australasian College of Physicians (Royal Australasian College of Physicians 2010). A "Traffic Light" system, especially a mandatory one, has met much opposition, notably from the Australian Food and Grocery Council (AFGC) but at least a limited "Traffic Light" system has crept into some health systems and schools (Government of Western Australia Department of Health 2015). There is a good reason for having a simple system. Fifty or sixty years ago supermarkets were in their infancy, offered relatively few items (2-3000) and people ate recognisable food – vegetables, legs of lamb, steak, fruit, and milk, often at home. Fast-food outlets were rare. Now, supermarkets are massive and offer 55,000 items, many unrecognisable from a nutritional viewpoint (FSANZ, 2011). Likewise, fast-food outlets offer a surprising array of products. My experience is that final year university students, who enroll for a course in nutrition, cannot decipher a food label. We cannot expect the general population to have more nutritional knowledge than these students and thus a simpler system, such as "Traffic Light" labels, seems advantageous. Another priority is to teach children about food from an early age such that they understand it and can prepare it by the time they leave school.

Vegetarianism and athletic performance

One often hears that a vegetarian diet cannot sustain a high level of athletic performance (Venderley and Campbell 2006). A poor knowledge of nutrition among coaches and trainers of athletes exacerbates the thinking (Shifflett *et al.* 2002). The reasons given invariably involve protein, such as not enough protein or not enough high quality protein in a vegetarian diet to sustain the growth and repair of muscle. The evidence suggests otherwise. Many athletes including sprinter, Carl Lewis, ironman, Dave Scott, distance runner, Pavo Nurmi, and tennis star, Martina Navratilova, climbed to the top of their sports on a vegetarian diet. Of course, one could argue that diet had nothing to do with their success and that innate talent and other factors overcame dietary disadvantage. This argument is much weaker when directed against planned studies such as the "Deutchlandlauf" or German run of 1987 in which 50 lacto-ovo-vegetarians and 60 omnivores ran 1000 km in 20 days. Half the runners from each group finished the run and diet had no effect on the performance of the runners, with the average running time similar between groups (Eisinger 1994). Studies such as this led those reviewing the discipline to conclude that an "appropriately planned vegetarian diets can provide sufficient energy and an appropriate range of carbohydrate, fat and protein intakes to support performance and health" (Venderley and Campbell 2006). Vegetarian diets offer neither a benefit nor a detriment in physical performance (Niemann 1999) and, like any diet, "can be healthful and performance enhancing or it can be a haphazard eating style that comes up short in many nutrients" (Eberle 2013).

Microbial contamination of food

In Australia and the USA about 20-30% of people suffer food poisoning each year (Consumer Reports 2015; NSW Department of Primary Industry Food Authority 2016). The culprits are typically microbes in seafood, all types of meat, eggs and, to a lesser extent, vegetables. While there is no clear link between industrial animal production and outbreaks of food poisoning, the risk of a mass outbreak is forever present due to poor sanitation in large abattoirs and the wide distribution of meat. For instance, authorities in the USA recalled a single 13.5 ton batch of beef due to potential contamination with *E. coli* 0157:H7, a particularly dangerous strain (Consumer Reports 2015). In the USA 50% of the beef consumed is ground beef and this present particular problems some of which relate back to the husbandry of the animal (Consumer Reports 2015). A study by the same organisation showed that beef from conventionally raised cows (those from feedlots) was more likely to have more bacteria overall, as well as bacteria that are resistant to antibiotics, than was beef from more sustainably raised animals. Beef from cows raised only on pasture had one third the number of multi-drug resistant bacteria compared with beef from conventional farms. This is not surprising; farmers feed far more antibiotics to animals to prevent disease than are administered to humans (Union of Concerned Scientists (UCS) 2001).

Abattoirs and health

At least in the USA, working in an abattoir is among the most dangerous of occupations. Workers suffer injury rates, both minor and serious, that are four to five times the national average while rates for injuries associated with repetitive tasks are thirty times the national average (BLS 2002).

As of much concern is the mental health of abattoir workers. This should come as no surprise; killing animals and processing their carcasses is an unpleasant task and many argue that the industrial scale of killing makes it far worse. Upton Sinclair was probably the first to expose the link between mental health and abattoir work in his chilling book, “The Jungle” published a century ago portraying the abhorrent working conditions in a Chicago abattoir (Sinclair 1906). Since then the industry in the USA has changed dramatically with the relocation of abattoirs to rural areas, a depression of wages and an increase in immigrant labour (Winders and Nibert 2004). Studies of these communities have documented dramatic increases in crime but few researchers have attempted to identify the causes of these increased crime rates. For example, population booms or poverty might explain it; Fitzgerald *et al* (2009) made such a study comparing different industries and counties with and without abattoirs. Their results are startling: employment in abattoirs increases overall arrest rates and rates of arrest for violent and sexual crimes compared to other industries. In other words, abattoirs create more violent communities. In a related but much smaller study in Australia, Richards *et al* (2013) used a “propensity for aggression” scale to compare farmers and meatworkers. They found far more aggression among meat workers.

Other public health issues

The World Health Organisation regards zoonoses as “perhaps the biggest cause of public concern with meat” (FAO 2014). They define zoonoses as “Any disease or infection which is naturally transmissible from vertebrate animals to man”, of which we know of over 200. The prevalence of tuberculosis indicates the scale of the threat: this disease causes more deaths worldwide than any other infectious disease, with an estimated 1.1 million deaths and about 10 million new cases in 2014 (World Health Organization 2014). Bovine spongiform encephalitis (BSE) – mad cow disease, provides another example although we do not yet know its full effects. Its cause is an absurd practice of modern animal husbandry: feeding processed animal remains to herbivores. Feeding meat meal from sheep infected with scrapie to calves exposed half a million people to the risk of variant Creutzfeldt-Jacob Disease (vCJD) (Horn 2001), a fatal disease that does not appear for many years (Thompson 2001). Another example is the fear of a new avian influenza, such as H5N1 that spread from chickens to humans and kills about 60% of those who contract the disease (Rümke *et al.* 2008). Attempts to curb the outbreaks of BSE and avian flu cases resulted in the destruction of hundreds of thousands of animals globally (BBC 1997), (FAO 2016b).

Semi-vegetarianism – good for the environment

For most of human history (ca 180,000 years), the various races of *Homo sapiens* fed themselves by foraging for wild plants and hunting animals. It was not until about 10,000 years ago that societies in the Fertile Crescent (the area encompassing the Nile, Tigris and Euphrates Rivers) began the domestication of plants and animals. Even then and right up to the Industrial Revolution humans used mainly their own energy to obtain food. Hunting, gathering and early agriculture had obvious limitations: those involved had to secure more nutrients than they expended. In the last two hundred years modern food production has superseded foraging. Change accelerated from the mid 19th century with developments such as the commercial supply of mixed fertilizer, which enabled farmers to dissociate the production of crops and animals, and the invention of the steam tractor. But agriculture changed completely with inventions during the twentieth century (Mazoyer and Roudart 2006). Three inventions or developments stand out: the growing use of the internal combustion engine that powers all manner of agricultural machinery; the Haber-Bosch process for the industrial synthesis of ammonia and urea, the main forms of nitrogen fertilizer; and the invention of refrigeration that allows the marketing around the world of a perishable commodity, like meat. Along with genetic selection of animals and plants, agriculture is now mechanised and specialised and the energy used to produce food greatly exceeds the energy in the products. Monocultures of animals and plants, placed hundred of kilometres apart, have replaced mixed farms. Whereby once agriculture relied solely on solar energy to drive photosynthesis, it now relies almost entirely on past photosynthesis in the form of fossil fuels. On this basis alone, modern agriculture is unsustainable.

Of all the agricultural industries, the intensive animal industries are the major offenders. Our meat consumption habits take a serious toll on the environment. The production, processing and distribution of meat requires vast amounts of feed, water, fuel and agricultural chemicals while contaminating our land, air and water with a variety of pollutants, including dust and odours. Among these, the intensive production of beef and dairy is particularly harmful generating 10 to 40 times more greenhouse gas emissions than the production of common vegetables and grains such as rice, lentils and broccoli (Pimentel and Pimentel 2003; Environmental Working Group (EWG) 2011). Worldwide, livestock production produces 7.1

gigatonnes of CO_2-equivalents per year, representing 14.5 percent of all anthropogenic GHG emissions (Gerber *et al.* 2013). In fact, a shift has occurred in the animals that emit methane with domesticated ruminants replacing wild ruminants as the chief emitters. For example, in the USA cattle have replaced the vast herds of bison that once belched methane across the American plains. This raises another point about animal production – it endangers wild animals. Information published by WWF International (2014) suggests that populations of vertebrate species have declined by 50% in the last forty years with the worst losses in South America. This coincides with the clearing of land for the grazing of beef cattle and the cultivation of soybeans.

Proponents of cattle feedlots argue that the animals grow faster and thus produce less methane than do cattle grazing pasture (e.g., North American Meat Institute (NAMI) 2014). But grazing animals at appropriate stocking densities can utilise land that is unsuitable for cropping, recycle nutrients and use foods that humans cannot use. Furthermore, domesticated ruminants can use crop residues, such as the stubble that remains after harvesting grains, and replenish nutrients. Also, grazing animals require minimal use of fossil fuels to transport their food and wastes. The advantages of grazing occur only when domesticated ruminants graze land that is unsuitable for crops or when they are part of crop rotations. The benefits expire when the clearing of land occurs specifically to feed cattle, as happens in the Amazon where 80% of the land cleared is for grazing (Karstensen *et al.* 2013). So, the troubles with ruminants arise when clearing land for them to graze or when we intensively house them and feed them inappropriate diets. This is the same problem with the growing demand for chicken and pork and indeed all IFAP: the animals eat feeds that are suitable for humans (Wallis 2014).

Growing crops is expensive in many ways. In the modern production systems they require large amounts of fertilizer, fuel, pesticides, water and land. Also, the methods of tilling employed in many places cause soil erosion that is unsustainable. The Organisation for Economic Co-operation and Development report that two-thirds of the world's farmlands are 'somewhat degraded' and the other third is 'strongly degraded' (Prosser *et al.* 2003). Australia is no exception with rates of soil erosion that are above natural rates evenly distributed across the country. Even grazing lands have erosion rates 2-5 times natural rates, while the rates for croplands are 5-20 times higher (Prosser *et al.* 2003; Loughran *et al.* 2004).

Thus, growing crops and then feeding them to animals is ludicrous. It makes less sense when the animals are ruminants, due to the inefficiencies described previously, or with animals housed intensively. In these cases, one must transport food to the animals and use transport to remove and spread the wastes. Pollution of waterways is invariably a problem near intensively housed animals. The figures are startling and no more so than in the USA with a large population of meat eaters. The report by the Environmental Working Group (EWG) 2011) estimates that growing livestock feed in the USA requires 60 million ha of cropland, 7.7 million tonnes of nitrogen fertilizer and 30,000 tonnes of pesticides. The process generates copious amounts of nitrous oxide, a greenhouse gas 300 times more potent than carbon dioxide, while cattle generate 20% of the country's methane emissions. Pimentel and Pimentel (2008) described the situation eloquently:

> *"If all the 323 million tons of grain currently being fed to livestock were consumed directly by people, the number of people who could be fed would be approximately 1 billion."*

Apart from the environmental pressures that I mention, feeding crops to animals has other rather subtle effects, one example being the influence of soybeans on the environment. While many people will think of soybeans as the basis of East Asian foods like tofu and soy sauce, humans eat little directly. Instead, the oil from soybeans enters the food manufacturing chain and the residual meal (about 80%) becomes the protein mainstay of the intensive animal industries. Even Australia is a massive importer of soybeans shipping in 12 times the 50,000 tonnes it produces (M'Gee 2011). That 50,000 tonnes contains 4% of the protein requirements of the Australian population (24 million people requiring 60 g of protein per day; soybeans contain 40% protein); the imported soybean meal would cover 60% of the Australian requirement but almost all goes to feeding animals. The main exporters of soybeans are Argentina and Brazil and, to a lesser extent, Paraguay and Bolivia. These countries either occupy part of Amazonia (Brazil and Bolivia) or encompass other areas of ecological importance such as the Gran Chaco, which cuts across parts of all of these countries and the Yungas in Argentina. In 1914 Argentina had about 105 million ha of forest but now has about a third of that (Carey and Oettli 2006). According to the FAO, the countries with the highest net loss of forest area between 1990 and 2000 were Argentina and Brazil (FAO 2001). Between 1990 and 2015 the annual percentage loss of forests were 1% (Argentina), 0.5% (Bolivia), 0.4% (Brazil) and 1.4% (Paraguay). Soybeans are largely responsible for this loss and so these countries are effectively exporting their greenhouse gases to feed animals in other countries. Thus, the demand for meat and specifically meat from IFAP causes deforestation. Furthermore, since many farmers around the world cannot compete economically with these exported soybeans, they do not grow soybeans. But they often do not grow other legumes – a vital part of crop rotation and soil replenishment. Remarkably, the world soybean industry leads to the depletion of soils in other parts of the world (Greenpeace 2006)!

In summary, while modern agriculture is unsustainable, animal production and particularly that of intensively housed animals is the most damaging on the environment. The production of one kg of animal protein requires ten times the energy needed to produce one kg of plant protein (Pimentel and Pimentel 2008). Eating less animal protein must be good for the environment. No organisation summarises it better than the Environmental Working Group (2011) when they equate the effect of eating meat with driving a car:

> *"If you eat one less burger a week, it's like taking your car off the road for 320 miles"*

Or, on a bigger scale:

> *"If everyone in the U.S. ate no meat or cheese just one day a week, it would be like not driving 91 billion miles – or taking 7.6 million cars off the road"*

Either scenario would mean far fewer animals. This alone must be good for animals, something I discuss in the next section.

Semi-vegetarianism – good for animals

Animal welfare is a tricky subject. It acknowledges that we use animals – for food, research, entertainment, etc, but that we look after them. In contrast, some animal rights organisations, such as People for the Ethical Treatment of Animals (PETA), argue that "*animals are not ours to eat, wear, experiment on, use for entertainment, or abuse in any other way*". As I write, PETA are arguing to change the name of Tasmania's Eggs and Bacon bay to Apple and Cherry bay (Guardian 2016)!

But a good starting point to discussing welfare is to question how well we can treat animals when we raise more than 60 billion of them for slaughter each year. That's about nine for every person on earth (FAOSTAT 2014) (Table 1). In Australia we raise 600 million giving each of us about 25 animals. In both Australia and the world chickens comprise over 90% of these animals, something that would not be possible without IFAP. Thus studies of welfare should focus on these methods of production. But, regardless of farming methods, one simple way to improve animal welfare is to reduce the numbers and focus on individuals.

Another good starting point is to think about the animals we interact with including those that we farm. Jane Goodall did this most eloquently in her foreword to the Encyclopedia of Animal Rights and Animal Welfare:

> *"Once we are prepared to accept that it is not only humans who have personalities, not only humans who are capable of rational thought and simple problem solving, and above all, not only humans who can experience emotions such as joy, sorrow, fear, despair and mental as well as physical suffering, then we are surely compelled to have new respect not only for chimpanzees but also for so many other amazing animal species."* (Goodall 2013)

She proceeds to mention that all that sets humans apart is their ability to communicate by means of special spoken and written language and that this lays upon us certain responsibilities to the rest of the animal kingdom.

Like so many important issues, the "us" versus "them" condition makes animal welfare languish. The key problem appears to be the interpretation of "welfare". Most people probably agree with the basic tenets, that welfare means the "state of being or doing well" but that is where agreement ends. There are three main interpretations. One group regard "welfare" as concerning the feeling of animals and that they should be able to experience life's feelings – comfort, contentment and the normal pleasures of life while being mostly free from unpleasant states such as pain, hunger and other forms of discomfort. A second interpretation has to do with biological functioning – thriving, growing and reproducing normally and being reasonably free from malnutrition, disease and abnormal behavioural and physiological conditions. The third interpretation is that animals should exist in reasonably natural environments and be able to develop their natural capabilities. Two examples demonstrate the sources of disagreement (Bekoff and Meaney 2013). The first is the farrowing crate – a structure that confines the sow and prevents her crushing her piglets. The second example is of the laying chicken housed individually in a battery cage. In both of these cases, those advocating biological functioning as a measure of welfare would indicate the excellent production of live piglets and eggs, and the freedom from disease, predators and adverse environmental conditions. Those advocating a natural environment would find both abhorrent. Those who judge feelings might find a comfortable farrowing crate acceptable (depending on how the sow spends the rest of her life), but would find the battery cage unacceptable.

Rather than trying to define a scale of welfare it may be pertinent to base welfare on the five "freedoms" that animals should enjoy. These include (1) freedom from hunger and thirst by providing adequate food and clean water; (2) freedom from discomfort by providing an environment with adequate shelter and clean and comfortable resting material; (3) freedom from pain, injury or disease through prevention and the provision of prompt treatment; (4) freedom to practice normal behaviours by providing adequate space, an enriched environment and appropriate company; (5) freedom from fear and distress through husbandry that avoids mental suffering. Of utmost importance is that "freedoms" apply to individuals. It does not matter that 99.9% of broilers in a shed are comfortable if 0.1% are in distress. That said, fewer sheds will presumably mean fewer distressed individuals.

Some freedoms are easy to assess when examining individual animals but much harder to assess with IFAP, such as a shed full of broilers. For instance, a sow in a farrowing crate may enjoy the first three freedoms but the last two are questionable. In contrast, an individual chicken in a broiler shed may enjoy none of them because it struggles to get food, water and a resting place in a competitive environment, it suffers lesions that go unnoticed in a shed of 100,000 birds, it has no chance of practicing normal behaviour and thus lives a life of distress even though most birds in the shed are in much better condition.

Another way to judge how we should treat animals is to ask the public. Voiceless, an animal rights organisation that aims to raise awareness of IFAP and other issues concerning animals, did this by commissioning the American organisation, Humane Research Council (HRC), to undertake their Animal Tracker survey in Australia. There was support for both farming animals and for looking after them. While 70% of the 1041 adult respondents deemed that using animals for food is necessary for human survival, 60% thought that farm animals deserve the same legal protections as companion animals. Three quarters of people think that pigs and both laying and meat chickens should have access to the outdoors. Almost 70% want to see battery cages banned, 50% want to see the end of farrowing crates and over 40% would support a ban on the live export of animals for slaughter. Respondents regard education about humane issues as a key with 86% of them stating that it is important or very important (Humane Research Council 2014). Education is the key to the view of renowned surgeon Professor Charlie Teo (Teo 2016):

> *"I think that the first thing we need to do is become aware of where our food comes from and how farm animals are treated. If more people became aware of these things there would be huge public outcry, which would lead to change."*

The common-morality approach is a formal way of galvanising public opinion on the issue and a method that Rossi and Garner (2014) used to review IFAP. Their view was "whether a well-informed person would judge IFAP indefensible if appropriately applying their core beliefs about what ethical principles we should espouse, what kinds of people we should be, and what kinds of argumentative standards apply to ethics." They concluded that IFAP is morally indefensible and that any defense of IFAP is often both vague and associated with credibility and bias.

But most pertinent to the present thesis is that they find IFAP indefensible not only because it imposes significant and unnecessary harm and risk to animals but also to humans – not only those that live today but to future generations too. The harms to humans are those I have mentioned in previous sections – to their health, to the environment and to their economic systems. All harm – to animals and to humans, is unnecessary because it is avoidable if we eat less meat by adopting a semi-vegetarian existence and relying on meat from sustainable farming. The system of IFAP exists due to powerful economic and political interests and the failure of the industry to pay the costs that I describe.

Change for the better – semi-vegetarianism

The evidence that I present leaves little doubt that if we could all switch to some form of vegetarian diet then there would be astounding benefits for the environment, humans and animals. Even so, I think that it is the wrong approach even if we disregard the impossible and imagine that people would abandon their meat eating. There are three main reasons supporting a semi-vegetarian rather than a vegetarian or vegan existence. The main argument is that animals can convert substances that are of little value into food suitable for humans. Second, small amounts of animal protein, especially milk, are most beneficial to human nutrition. The result of using animals is that some may need to be killed – old animals, males of dairy or laying strains, many in times of food paucity or drought. Finally, animals are the oldest and most efficient fertilizers of the land. Let me examine each of these points.

Animals as converters of waste into food

It is not sensible for everyone to pursue a vegan diet because animals are such an important part of agriculture. They supply high quality protein, as meat and dairy products, they fertilise the land and in many less developed countries they still provide the power to work the fields. Also, as Fairlie (2010) mentions, animal lipids may be important in places where the production of oilseeds is limited. In some places animals play all of these roles. For example, in India it is common to see a buffalo providing milk, ploughing a field, transporting goods and fertilising the land as it moves. Need it surprise us that India has 75 million dairy farms employing 90 million people of whom 75 million are women (Grain 2014)! If we are to accept the benefits of a lacto-ovo-vegetarian diet, then we need to accept also that there will be surplus animals. It seems sensible to use the meat from these animals to supply valuable protein.

So far I have mentioned grazing animals only. This has a logical reason. Cellulose and hemicellulose – the main components of the plant cell wall (also called fibre), are among the most abundant of all naturally occurring organic compounds. Also, they are readily available in the residues of crops and in plants growing on rangelands that are unsuitable for cropping. Humans digest little of these compounds although consuming fibre seems to offer health benefits. In contrast, most herbivorous animals, including foregut fermenting animals, such as our domesticated ruminants (cattle, sheep, goats and buffalo) and wild animals (e.g., deer and kangaroos) and hindgut fermenters (rabbits, hares, horses) can flourish on these substances thus turning something that humans cannot eat into animal protein – meat, milk and more animals. Furthermore, supplements of soluble carbohydrate as molasses and of non-protein nitrogen as urea will speed the digestion of poorer quality hay and allow domesticated ruminants to eat more and thus produce more (Kunju 1988). The combination of small numbers of animals fed crop residues and agro-industrial wastes supplemented with molasses-urea blocks has many advantages. Apart from the huge increase in production that comes with a small supplement, the process makes use of crop wastes and spares land for growing crops that humans eat.

Another obvious use of animals is to employ them as converters of the billions of tonnes of food that those living in the developed world waste each year. According to Foodwise (2013), each year Australians waste four million tonnes of edible food valued at $8 billion. If this food represents all of the Australian diet then it contains the annual nutritional needs of a third of the population (calculated from Australian women, aged 25-44 and Australian men aged 19-24, eating 1300 and 1680 g of food per day; (ABS 1997)). Assuming this waste is about 30% dry matter and that each gram of dry matter contains 16 kJ of metabolisable energy and 0.16 g of protein, it would rear 3.8 million pigs to 100 kg and supply 40% of Australia's pork. More importantly, it would preserve an enormous amount of crops for consumption by humans elsewhere. Unfortunately, Australian legislation prevents swill feeding – feeding anything that has contacted meat to animals. This makes the feeding of most waste impossible. In contrast, Japan has various schemes for recycling the 20 million tonnes of food that they waste each year including fermenting it for pig food (Maeda 2008). There are other useful converters of waste, most notably chickens to produce eggs and meat but also rabbits, both of which Europeans used extensively during the food shortages of World War 2 (MOMA 2010). Just as there are several means of recycling waste through animals there are more useful waste products than the obvious food waste. These are often highly nutritious byproducts including brewer's grains, yeast extracts, vegetable residues and grains spoiled before harvest.

The benefits of small amounts of animal protein, particularly milk, for human nutrition

While those in the developed world suffer detrimental health partly through eating too much meat, the most impoverished suffer the consequences of not getting enough protein. Indeed, they do not get enough food. Government agencies now recognise that vegetarians can meet their nutritional needs by eating a mixed diet containing numerous grains, vegetables, fruits and legumes. Such a mixed diet is often unavailable to many people, who consequently suffer nutritional deficiencies. This is where small amounts of animal protein and supplements are vital. Figures for the consumption of meat depict the startling unfairness of its distribution. People in wealthy countries, such as the USA, Australia and Kuwait eat over 100 kg per year while those in impoverished countries – Burundi, Bangladesh and Eritrea eat about 5 kg per year (Chartsbin Statistics Collector team 2013). It is unclear how to reverse this situation. The plausible solution is for people in developing nations to eat a plant-based diet supplemented with small amounts of animal products from livestock raised sustainably. These might be cows, buffaloes and goats producing milk (and occasionally meat) while eating mainly plant residues supplemented with molasses, urea and minerals. Pigs and village chickens are another option as is the sustainable harvesting of bushmeat. The worst outcome would be for developing nations to try to emulate the IFAP found in developed countries. Unfortunately, this is now occurring with IFAP common in both China and India.

Animals as fertilisers of the land

A principal aim of any agricultural system should be to return nutrients to the soil efficiently. A particular concern is phosphorus. The earth's crust contains much lower concentrations of phosphorus than animals require and thus animals must concentrate it. The heavily weathered soils in Australia often have very low concentrations of this element and require additions of fertiliser to enable efficient growth of crops. Free roaming animals, especially grazing animals, are the original fertilisers of the land and do an excellent job of returning most nutrients. However, harvesting animals and crops along with weathering and erosion will deplete nutrients, especially phosphorus, which we must restore.

One way to restore nutrients is by recycling manure, bones and human sewage but this involves two main problems caused by the urbanisation of humans and IFAP. Both require the delivery of substantial amounts of food and the removal of large amounts of excrement containing nutrients. Put simply, the farmlands that need fertilising and the fertiliser are distant from one another; nutrients are concentrated in one place and depleted in another. While animal manure may be reasonably clean in being free of industrial pollutants its abundance means that it must be transported and spread over vast areas to dilute it. Also, the easiest way to transport manure is by diluting it, which requires more transport and sophisticated machinery to spread the liquid waste. Some countries, already saturated with manure, are already beyond this stage. The Netherlands, where the mineral excess from cattle and pig manure is now 50,000 tonnes of nitrogen and 21,000 tonnes of phosphates, is a good example. Their only solution is to farm fewer animals (The Beefsite.com 2010). Although there is much less of it, human sewage presents a bigger problem because it is usually contaminated with industrial pollution. The sludge that remains after removing water contains a lot of nutrients contaminated by other chemicals so that anaerobic digestion might be the best use.

In summary, the advent of synthetic fertilisers allowed the dissociation of animal production from crop production. This, in turn, led to the growing of vast monocultures of crops and of animals far apart from each other, with no obvious use for the mountains of manure. They are just another source of pollution where once animals spread manure on the land. The problem would largely disappear if we all ate less meat.

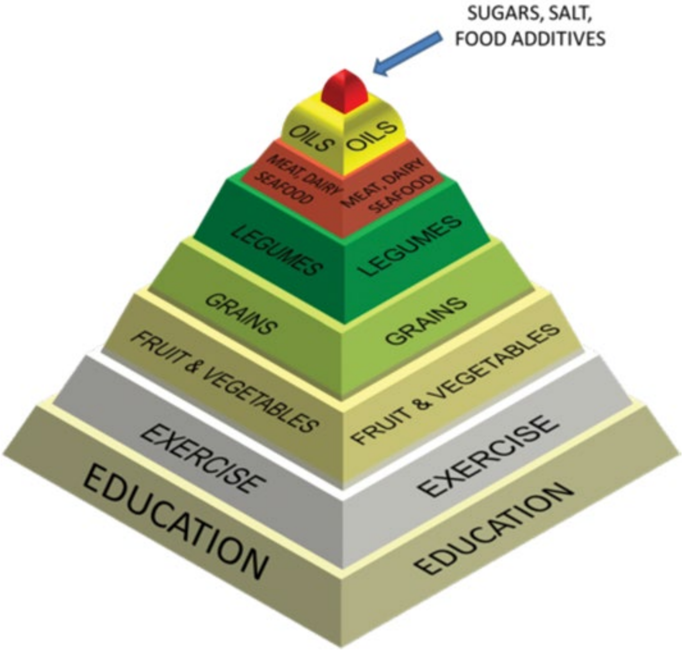

Figure 1. A pyramid describing a semi-vegetarian existence. Note the emphasis on an education about food and an active lifestyle before any consideration of diet. The miniscule amounts of added sugars, salt and other food additives in the diet requires one to prepare food from whole ingredients. Of course, this could change if the fast-food industry and other eating establishments followed the dietary guidelines.

Conclusion

The agricultural system that prevails in the developed world and more and more in the developing world is disastrous for humans, the environment and for animals. It is a pipe dream to think that the system will change because powerful political and economic entities protect it. Even so, it could change if we ate less meat and this could happen with education. How would we want the "new" farming system to look? It already exists in Virginia: the Salatin's "family owned, multi-generational, pasture-based, beyond organic, local-market farm". This farming system would link with a food pyramid for a semi-vegetarian existence (Figure 1). This means educating people about the origins of their food so that they can make informed decisions about what they eat. It means educating children about how to live a healthy existence and to prepare healthy meals. It means teaching people to say no to the purveyors of junk. The incentives are huge: by doing some exercise, eating less junk, less meat and more plants you can live a longer healthier life without the burden of obesity and metabolic disease. And in doing so, you take some burden off the health system, help protect the environment and greatly improve the welfare of animals.

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